IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicant:	Ori J. BRAUN, et al.
Serial Number:	09/868,405
Filed:	June 14, 2001
Title:	SELF GATING PHOTOSURFACE
Art Unit:	2615
Examiner:	YE, LIN

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Commissioner for Patents
P.O. Box 1450
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APPEAL BRIEF

Sir:

Further to an Advisory Action dated May 3, 2006 and a Notice of Appeal filed on May 31, 2006, the following is applicants brief on appeal.

(c1)(i) Real Party of Interest:

The real party of interest in the present application is:

3DV Systems Ltd.

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(c1)(ii) Related Appeals and Interferences:

None

(c1)(iii) Status of claims:

Claims 1-17 and 19-32 of which claims 1, 14, and 27 are independent claims, are pending. All the claims stand rejected and all are appealed.

(c1)(iv) Status of Amendments:

There are no current outstanding amendments

(c1)(v) Summary of Claimed Subject Matter

In the summary below, limitations recited in a given independent claim are given in italicized script and references in the specification and figures to features and limitations recited in the claims are given in plain script between square brackets. A first time a reference numeral in a figure is noted, the figure in which the numeral appears is noted together with the numeral. Thereafter, if the numeral is referenced, the figure in which the numeral appears is not noted unless the numeral is referenced with respect to a different figure. Discussion of material in a particular claim is given in plain script.

INDEPENDENT CLAIM 1

Independent claim 1 claims a semiconductor surface [Fig. 1 reference numeral 20; page 9 line 7] comprising a plurality of light sensitive pixels [Fig. 1 reference numeral 21; page 9 line 8]. Each pixel [21] comprises an electronic circuit [Fig. 1 ref 40; page 9 line 9] formed on or in the semiconductor surface [20]. The circuit comprises:

1. a photosensor that generates a signal responsive to light incident thereon at an output thereof [Fig. 1 reference numeral 44; page 9 line 28]

2. a current integrator [Fig. 1A reference numeral 50; page 5 line 25-26 - page 9 line 29;]

3. a switchable current source [Fig. 1A (numerals 48, 49, 51 and 60); page 5 line 27 - page 6 line 8; page 10 lines 1-4] *that can be turned on or off, which when on, provides a predetermined current that flows into the integrator;*

4. circuitry [Fig. 1A (numerals 46, 51, 58); page 3 line 33 - page 4 line 13; page 9 line 32 - page 10 line 3] *that turns the switchable current source on at a start time and subsequently turns the source off at a stop time and generates a signal responsive to current from the current source that is integrated by the integrator between the start and stop times and wherein one of the start time and stop time is determined responsive to a signal generated by the photosensor.*

In the discussion on page 10 line 18 - page 11 line 5, the source is turned on by the controller and turned off responsive to the photosensor. An alternative operating procedure, in which the source is turned on responsive to the photosensor and turned off by the controller, is noted on page 19 line 22- 26.

DEPENDENT CLAIM 5

Dependent claim 5 claims that the semiconductor surface claimed in claim 1 is formed as a monolithic integrated circuit [page 5 lines 15-18, page 6 lines 9-10] .

INDEPENDENT CLAIM 14

Independent claim 14 is an apparatus claim that claims a 3D camera [Fig. 3 reference numeral 182] for measuring distances to points on an object. The camera comprises:

1. a semiconductor surface [Fig. 3 reference numeral 180]

2. comprising a plurality of light sensitive pixels [Fig. 3 reference numeral 192] *wherein each pixel comprises*

3. a circuit [Fig. 3 reference numeral 194] *having a photosensor* [Fig. 3 reference numeral 44], *a switch* [Fig. 3 reference numeral 196] *and an output terminal* [Fig. 3 the side of switch 196 connected to buss 72], *wherein said circuit provides a signal on said output terminal only while light is incident on said photosensor and said switch is closed* [It is noted that at any given time, a signal exists on the output terminal if and only if light is incident on the pixel at the given time and switch 196 closed];

4. a fan beam [Fig. 3 reference numeral 132] *controllable to illuminate the object from at least one position of the fan beam, which position is defined by a scan angle* [Fig. 3 reference letter θ], *so that light from said fan beam is reflected by said object to at least one of said pixels,*

5. a controller [Fig. 3 reference numeral 190] *that controls the fan beam* [132] *to illuminate the object at a plurality of scan angles of the fan beam, wherein for each scan angle, while light from the fan beam illuminates the object, the controller simultaneously closes a plurality of the switches* [196] *and for a pixel* [192] *that generates a pulse when the pixel's switch is closed, the controller determines a distance from the pixel to the object by triangulation responsive to the scan angle and the position of the pixel in the semiconductor surface.*

DEPENDENT CLAIM 16

Dependent claim 16 claims that the circuits of the 3D camera are formed as elements of a monolithic integrated circuit [page 7 lines 17-18].

INDEPENDENT CLAIM 27

Independent claim 27 claims a method of measuring distances to regions of an object comprising:

1. providing a semiconductor surface [Fig. 3 reference numeral 180] *having a plurality of light sensitive pixels* [Fig. 3 reference numeral 192], *each of which provides an output signal responsive to light thereon only while illuminated with the light;*

2. illuminating said object with light from a fan beam[Fig. 3 reference numeral 132] *of light having a position defined by a scan angle*[Fig. 3 reference letter θ] *so that light from the fan beam is reflected by the object to at least one of said plurality of pixels;*

3. simultaneously sensing signals from a group of pixels in the semiconductor surface to determine which of the pixels in the group is providing a signal;

4. determining the scan angle for the pixels in the group of pixels;

5. using locations of pixels that provide signals and said determined scan angle to determine distances to regions of said object.

In an exemplary embodiment of the invention, the pixels are arrayed in a rectangular array of rows and columns of pixels. Signals from all pixels in a same column of pixels are sensed via a same signal line [Fig. 3 reference numeral 214]. Signals are simultaneously sensed from all pixels in a same row of pixels via the respective signal lines to which they are connected. At a given scan angle **[θ],** light from the fan beam reflected by the object illuminates substantially a stripe, an "image strip" [Fig. 3 reference numeral 152] on the semiconductor surface. Since a pixel can provide a signal only while it is illuminated, only those pixels in the image stripe can provide signals. When signals from all pixels in a given row are simultaneously sensed, only those pixels at the intersection of the row and image strip transmit a signal. And a pixel that does provide a signal, provides it along a particular signal line to which it is connected. The location of a pixel that provides a signal is therefore known form the row that is being sensed and the signal line over which the signal is provided. By determining the scan angle **[θ],** a distance to a location of region of the object illuminated by the fan beam can be determined. Note discussion on page 18 line 15 to page 19 line 4.

(c1)(vi) Grounds of Rejection to be Reviewed on Appeal

(vi.1) Rejection of claims 1-2, 4-9 and 10 under 35 U.S.C. §102(b) as being unpatentable over US 5,446,529 to Stettner et al.

(vi.2) Rejection of claims 3, 10-17 and 19-32 as being unpatentable under 35 U.S.C. §103(a) over US 5,446,529 to Stettner et al. in view of US 5,015,868 to Park.

(c1)(vii) Arguments

<u>Argument with respect to (vi.1): Rejection of claims 1-2, 4-9 and 10 under 35 U.S.C. §102(b) as being unpatentable over US 5,446,529 to Stettner et al.</u>

Independent Claim 1

Claim 1 recites a photosensor and "a switchable current source that can be turned on or off, which when on provides a predetermined current that flows into the integrator" and a controller that turns the current source on or off *responsive to a signal generated by the photosensor*.

In the advisory action, the Examiner contends that:

"Stettner clearly discloses in Figure 5, a current integrator (capacitor 25) receives an signal as a predetermined current generated by the photosensor (photodiode 41) (See Col. 7 lines 14-17)". and that Stettner clearly discloses,

"a switchable current source (MOSFET 23, 24 and shift registers 26 are considered as the switchable current source to deselect and select current flows into the integrator 25 responsive to the signal generated by a photosensor, see Col 6, lines 31-47 and Col. 13, lines 21-49) that can be turned on or off …

Applicants traverse and respectfully point out that current provided by Stettner's photosensor is dependent on light intensity incident on the photosensor, which is variable and therefore not predetermined. Stettner notes (column 8 line 65- column 9 line 10) that the incident light is affected by noise water absorption and scattering and "decays almost exponentially with depth and a large receiver dynamic range is required to obtain good operational range" (column 9 lines 8- 10). And, as presented in applicants' reply filed April 12, 2006, current provided to Stettner's capacitors (the integrator 25 referred to by the Examiner) is current generated

responsive to "return signals measured in 10's or 100's of photons" by "a photon signal amplifier with enough gain to amplify the signal above receiver noise" (column 9 lines 27-32).

Stettner's own statements must therefore be understood to declare that current from Stettner's photosensor is not, and cannot be, predetermined.

In addition, as the applicants also submitted in the April 12 reply, "Stettner's circuitry does not comprise a controller that turns any current source on or off responsive to a signal generated by a photosensor". Switching in Stettner's circuit appears to be provided by an M bit shift register 26, (Fig. 5 fig 7) responsive to clock pulses ϕck (column 6 line 37; column 11 line 66; column 12 lines 43, 56; column 13 lines 33 - column 14 line 5) provided by a clock and/or by a timing generator that provides ϕrw, ϕint and ϕrst (column 11 line 54 - column 12 line 13). The only other switching signals, row and column switching signals ϕrow and ϕcol (column 12 lines 35, 36), are not indicated as being generated responsive to a photosensor signal and applicants submit that it is far from reasonable to expect that the row and column signals are generated responsive to a photosensor signal.

None of the switching in Stettner, whether reset switching, switching capacitors 25, or readout switching, is therefore performed responsive to signals provided by the photosensor. Certainly, no current source is switched responsive to signals generated by the photosensor.

In view of the above, applicants submit that a *prima facie* case of anticipation is not and cannot be supported by Stettner and that the claim is patentable over the cited art.

Dependent Claim 5

With respect to dependent claim 5, as argued in the April 12 reply, applicants traverse the 35 U.S.C. 102(b) rejection of the claim and submit that the limitation recited by claim 5, that the circuit is formed as a monolithic integrated circuit, is not anticipated by Stettner.

There is nothing in Stettner that teaches a monolithic integrated circuit comprising all the components recited in claim 1 from which claim 5 depends. All of Stettner's circuits comprise an array of unit cells 10, each having analog electronics 19 formed **on a chip unit 7.** As noted by the applicants in the reply filed on September 16, 2005, none of unit cells 10 comprises a light sensitive element that provides current to the cell electronics responsive to light. The light sensitive elements for each cell 10 are provided either by a photocathode 82 on an entrance window 8 that is not physically connected to the chip unit 7 (column 5 lines 59-60, Figs. 2-4) or by photodiodes 41 formed on a **separate diode array chip 40** (column 7 lines 36 and 37) each of

which is connected to a different unit cell 10 by an indium bump 42 (column 7 lines 33- 50 and Fig. 9) on chip unit 7.

Whereas the Examiner contends that the configuration of chip unit 7 (having units 10) and diode array chip 40 (having photodiodes 41) connected by indium bumps can be considered as providing "an electronic circuit ... formed on or in said semiconductor surface (e.g. the photodiode array 41 and unit cells 10 are integrated in and formed on the semiconductor surface 7 of the image sensor 3)" there is no way either of the Stettner configurations, even if *arguendo* considered an "electronic circuit ... formed on or in said semiconductor surface", can be construed to be a **monolithic** integrated circuit. The Stettner reference itself refers to the indium bump configuration as a "hybrid" (column 7 line 36, see also column 6 line 24) - the antithesis of a monolithic integrated circuit.

With respect to claim 5 the Examiner also states that "the Stettner reference discloses "wherein the circuit is formed as a monolithic integrated circuit (CMOS image processing chip 7)". Applicants submit that it is irrelevant whether or not chip 7 and its circuits are considered to be formed as a monolithic integrated circuit - chip 7 does not comprise the photosensitive elements claimed in claim 1 and therefore cannot be considered to anticipate claim 5. The Examiner's own rejection of claim 1 and response to the applicants arguments filed on September 16, 2005 attest that the circuits on processing chip 7 do not have light sensitive elements and that the light sensitive elements are provided by chip unit cell 10 connected to chip 7 by indium bumps, which indium bump configuration, as noted above, is considered by Stettner to be a hybrid circuit.

In view of the above, applicants submit that claim 5 is patentable over the cited art and is not *prima facie* anticipated by Stettner.

With respect to claims dependent on claim 1 or 5 whose patentability has not been specifically addressed in the above, applicants submit that these dependent claims are patentable, at least through their dependence on claim 1 or claim 5.

Argument with respect to (vi.2): Rejection of claims 3, 10-17 and 19-32 as being unpatentable under 35 U.S.C. §103(a) over US 5,446,529 to Stettner et al in view of US 5,015,868 to Park.

Independent Claim 14

Claim 14 recites the feature that each pixel, *e.g.* pixel 192, comprises a pixel circuit, *e.g.* pixel circuit 194, that provides a signal on its output terminal *only* while light is incident on said photosensor and said switch is closed - that is, at any given time, a signal exists on the output terminal of the pixel circuit, only if light is incident on the pixel at the given time and switch 196 closed.

The Examiner contends in the Advisory Action that a Stettner pixel has "an output terminal (output terminal 32) and that provides a signal on the output terminal only while light is incident on the photosensor and the switch is closed …" Applicants respectfully disagree.

Once a capacitor 25 in Stettner's pixel has been charged by current from photosensor 41, the charge may be read out and provided on output terminal 32 irrespective of whether the pixel is exposed to light or totally shielded from incident light.

As noted in applicants' reply of April 12, none of the light sensitive circuits in Stettner or Park produce signals only while light is incident on them. In general, they produce signals at some time after they are exposed to light. Stettner's integrators continue to provide output signals once they are charged after exposure to light and as noted on column 8 lines 50-53, "The three-dimensional image data is read off the array and digitized **during the relatively large time between laser pulses** (typically a few milliseconds)" (bold face added), *i.e.* when light is not incident on the array. Park's light sensitive circuit is a CCD (see, *e.g.* Abstract), which of course stores an image and produces signals long after light that generates the image is no longer present.

The combination of Stettner and Park cannot and does not provide the invention claimed in claim 14 and therefore does not support the *prima facie* rejection indicated by the Examiner. Claim 14 must therefore be considered patentable over the cited references.

Dependent Claim 16

Claim 16 recites patentable material for the same reasons that claim 5 recites patentable material since Park does not teach a monolithic circuit.

Independent Claim 27

Claim 27 is patentable over Stettner and Park at least for the same reasons that claim 14 is patentable over the references.

In view of the above applicants submit that all the claims argued are patentable over the art cited by the Examiner and claims dependent on any of the argued claims are patentable at least through their dependence. Applicants respectfully request that the Board reverse the ruling of the Examiner and allow all the claims.

Respectfully submitted,
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September 27, 2006

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(c)(1) (viii) Appendix - Claims under Appeal

1. A semiconductor surface comprising a plurality of light sensitive pixels, wherein each pixel of said plurality of pixels comprises an electronic circuit formed on or in said semiconductor surface, said circuit comprising:

a photosensor that generates a signal responsive to light incident thereon at an output thereof;

a current integrator;

a switchable current source that can be turned on or off, which when on provides a predetermined current that flows into the integrator; and

circuitry that turns the switchable current source on at a start time and subsequently turns the source off at a stop time and generates a signal responsive to current from the current source that is integrated by the integrator between the start and stop times and wherein one of the start time and stop time is determined responsive to a signal generated by the photosensor.

2. A semiconductor surface according to claim 1 wherein said current integrator comprises a capacitor.

3. A semiconductor surface according to claim 1 wherein the circuitry comprises a comparator having an input connected to the output of the photosensor and an output connected to an input of the switchable current source, wherein when light incident on the photosensor has an intensity greater than a predetermined intensity, the output signal from the photosensor switches the switchable current source between on and off.

4. A semiconductor surface according to claim 1 wherein the switchable current source comprises a flip-flop.

5. A semiconductor surface according to claim 1 wherein the circuit is formed as a monolithic integrated circuit.

6. A semiconductor surface according to claim 1 wherein the circuitry switches the switchable current source to on at the start time responsive to the signal from the photosensor.

7. A semiconductor surface according to claim 1 wherein the circuitry switches the switchable current source to off at the stop time responsive to the signal from the photosensor.

8. A 3D camera comprising a semiconductor surface according claim 1.

9. A 3D camera comprising:

a semiconductor surface according to claim 8;

a light source that illuminates objects in a scene imaged with said 3D camera with at least one light pulse;

wherein for each pixel of said plurality of pixels said start time is a time at which said at least one light pulse is radiated and said stop time is a time at which light from said at least one light pulse reflected by a surface region of said objects is incident on said pixel,

and including circuitry that computes a distance between said pixel and said surface region responsive to the time lapse between the start and stop times.

10. A 3D camera comprising:

a semiconductor surface according to claim 8;

a light source controllable to illuminate an object with light from a fan beam at known times, wherein position of the fan beam is defined by a scan angle and for different known times the scan angle is known and different;wherein said start time for said plurality of pixels is a time prior to illumination of the object by the fan beam and wherein for each scan angle light reflected from the fan beam by a region of the object is incident on a pixel of the plurality of pixels and said stop time for the pixel is a time at which reflected light is incident on the pixel; and

including circuitry that determines from the signal responsive to the current integrated between the start and stop times and the known times, a scan angle for the fan beam from which the pixel is illuminated and uses the scan angle and position of the pixel in the semiconductor surface to determine by triangulation a distance of the region from the pixel.

11. A 3D camera according to claim 10 wherein said fan beam moves between scan angles at a rate so that differences between said stop times for different pixels illuminated with reflected light from said fan beam at different scan angles are greater than a given time difference and

differences between said stop times for different pixels illuminated with reflected light from said fan beam at the same scan angle are less than the given time difference.

12. A 3D camera according to claim 11 comprising a reflector that reflects light to at least one pixel in said semiconductor surface for each of said scan angles and wherein for a given scan angle, differences between said stop time for said at least one pixel and said stop times for pixels illuminated by light from said fan beam reflected by said object are less than said given time difference.

13. A 3D camera according to claim 12 and including circuitry that determines said given scan angle from the location of said at least one pixel.

14. A 3D camera for measuring distances to points on an object comprising:

a semiconductor surface comprising a plurality of light sensitive pixels wherein each pixel comprises a circuit having a photosensor, a switch and an output terminal, wherein said circuit provides a signal on said output terminal only while light is incident on said photosensor and said switch is closed; a fan beam controllable to illuminate the object from at least one position of the fan beam, which position is defined by a scan angle, so that light from said fan beam is reflected by said object to at least one of said pixels,

a controller that controls the fan beam to illuminate the object at a plurality of scan angles of the fan beam, wherein for each scan angle, while light from the fan beam illuminates the object, the controller simultaneously closes a plurality of the switches and for a pixel that generates a pulse when the pixel's switch is closed, the controller determines a distance from the pixel to the object by triangulation responsive to the scan angle and the position of the pixel in the semiconductor surface.

15. A 3D camera according to claim 14 wherein said circuits are formed in or on said semiconductor surface.

16. A 3D camera according to claim 14 wherein said circuits are formed as elements of a monolithic integrated circuit.

17. A 3D camera according to claim 14 comprising signal receiving circuitry having a plurality of inputs and wherein pixels for which said switches are simultaneously closed have said output terminals connected to different inputs of said signal receiving circuitry.

18. (Cancelled)

19. A 3D camera according to claim 17 wherein said plurality of pixels comprises an array of pixels having rows and columns of pixels, wherein each pixel belongs to one row and one column of said array.

20. A 3D camera according to claim 19 wherein said output terminals of pixels in a same column of pixels are connected to a same input of said signal receiving circuitry.

21. A 3D camera according to claim 20 wherein the controller closes, substantially simultaneously, said switches of all pixels in a same single row of pixels.

22. A 3D camera according to claim 21 wherein the controller sequentially closes, row by row, the switches of all the pixels in a same single row of pixels.

23. A 3D camera according to claim 19 wherein columns of said semiconductor surface are parallel to the plane of said fan beam for all positions of said fan beam at which said fan beam illuminates said object.

24. A 3D camera according to claim 14 wherein an output of said photosensor is connected to a contact terminal of said switch.

25. A 3D camera according to claim 14 wherein said circuit comprises a comparator having a first input connected to said photosensor, a second input biased with a reference voltage and an output and wherein when light having an intensity greater than a predetermined intensity is incident on said photosensor, voltage on the first input rises above the reference voltage and the comparator generates an output signal.

26. A 3D camera according to claim 25 wherein said output of said comparator is connected to a contact terminal of said switch.

27. A method of measuring distances to regions of an object comprising:

providing a semiconductor surface having a plurality of light sensitive pixels, each of which provides an output signal responsive to light thereon only while illuminated with the light;

illuminating said object with light from a fan beam of light having a position defined by a scan angle so that light from the fan beam is reflected by the object to at least one of said plurality of pixels;

simultaneously sensing signals from a group of pixels in the semiconductor surface to determine which of the pixels in the group is providing a signal;

determining the scan angle for the pixels in the group of pixels;

using locations of pixels that provide signals and said determined scan angle to determine distances to regions of said object.

28. A method according to claim 27 wherein said plurality of pixels in the semiconductor surface is arranged in a rectangular array of rows and columns pixels.

29. A method according to claim 28 wherein the group of pixels comprises all pixels in a same row of pixels.

30. A method according to claim 29 and comprising sensing signals from pixels in the semiconductor surface in a plurality of rows of pixels sequentially, row by row.

31. A method according to claim 28 comprising providing a signal sensing means and wherein sensing signals comprises sensing signals from all pixels in a column of pixels on a same input of said sensing means.

32. A 3D camera according to claim 22 wherein said signal receiving circuitry comprises an encoder and said output terminals of pixels in a same column of pixels are connected to a same input of the encoder.

(c)(1) (ix) Evidence Appendix: None

(c)(1) (x) Related Proceedings Appendix: None